



**INVENTION:** Complex Walsh Codes for CDMA

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**WHAT IS CLAIMED IS:**

1. A means for the design of new complex Walsh orthogonal CDMA encoding and decoding over a frequency band with properties provide a complex Walsh orthogonal code with the real component equal to the real Walsh orthogonal code

provide a complex Walsh orthogonal code with the imaginary component equal to a reordering of the real Walsh orthogonal code, which makes the complex Walsh orthogonal code the correct complex version of the real Walsh orthogonal code to within arbitrary angle rotations and scale factors

provide a complex Walsh orthogonal code which is in correspondence with the discrete Fourier transform (DFT) complex orthogonal codes wherein the correspondence is twofold: the sequency of the complex Walsh orthogonal codes is the average rate of rotation of the complex Walsh codes and corresponds to the frequency of the DFT codes with sequency as well as frequency increasing with the code numbering, and the second correspondence is between the even and odd complex Walsh code vectors and the cosine and sine DFT code vectors respectively

provide a complex Walsh orthogonal code which has the sign values  $\pm 1$   $\pm j$  for the real and imaginary axes

provide a complex Walsh orthogonal code which has a fast decoding algorithm

provide a hybrid complex Walsh orthogonal code which can be constructed for a wide range of code lengths by combining the complex Walsh codes with DFT complex orthogonal codes

2. A means for the design of new complex Walsh orthogonal CDMA codes with the properties

provide complex Walsh orthogonal CDMA codes which reduce to the real Walsh orthogonal CDMA codes upon removal of the complex code components

provide complex Walsh orthogonal CDMA codes which reduce to the real Walsh orthogonal CDMA codes upon removal of the real code components

provide a means for the computational efficient encoding and decoding of the complex Walsh orthogonal CDMA codes

3. A means for the design of new complex Walsh orthogonal CDMA codes with the properties

provide the correct generalization of the real Walsh orthogonal CDMA codes to the complex Walsh orthogonal CDMA codes

provide a computationally efficient means to encode and decode the complex Walsh orthogonal CDMA codes

provide a means to extend the complex Walsh orthogonal CDMA codes to include the complex discrete Fourier transform (DFT) codes to allow greater flexibility in the choices for the code lengths

4. A means for the design of hybrid complex Walsh orthogonal CDMA codes with the properties

provide a means to provide greater flexibility in the selection of the code length by combining the complex Walsh orthogonal CDMA codes with the complex DFT orthogonal CDMA codes

provide a Kronecker product means to combine the complex Walsh orthogonal CDMA codes with the complex DFT orthogonal CDMA codes

provide a direct sum means to combine the complex Walsh orthogonal CDMA codes with complex DFT orthogonal CDMA codes as well as other complex Walsh orthogonal CDMA codes

provide a functionality means to combine the complex Walsh orthogonal CDMA codes with the complex DFT orthogonal CDMA codes

5. A means for the design of 4-phase Walsh orthogonal CDMA codes with the properties

provide 4-phase Walsh orthogonal CDMA codes which can be reduced to the 2-phase real Walsh orthogonal CDMA codes

provide 4-phase Walsh orthogonal CDMA codes which are the correct generalization of the 2-phase real Walsh orthogonal CDMA codes to 4-phases

provide hybrid Walsh orthogonal CDMA codes by combining the 4-phase Walsh orthogonal codes with the N-phase DFT codes with greater flexibility in the choice of the code length

6. A means for the design of 4-phase Walsh orthogonal CDMA codes with the properties

provide 4-phase Walsh orthogonal CDMA codes in the code space  $C^N$  which include the 2-phase real Walsh orthogonal CDMA codes in  $R^N$

provide 4-phase Walsh orthogonal CDMA codes which have computationally efficient encoding and decoding implementation algorithms

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